

HOW TO... Create order from chaos

Chaos may be defined by the absence of order but, as Mike Bedford illustrates in Excel, sometimes seemingly random actions can follow a specific set of rules

Can a series of random numbers create anything other than a random pattern? Common sense would say no, but you can test this with an easy experiment.

Mark out a large equilateral triangle using a piece of chalk. Label the corners 1, 2 and 3, and mark a point at a random position inside the triangle. This is your current position. Then throw a die. Since you need a three-sided die, ignore any throws other than one, two or three. Whatever number you get, mark a point halfway from your current point to the corner labelled with that number; this is your new position. Do this a few times, marking each current position. You'd think random throws would give a chaotic pattern, but the opposite is true.

You'd need to throw the die hundreds of times before you start to see what's happening. However, there's an easier way to do it. Here we show you how to do it onscreen using Excel.

1 Open a blank Excel workbook and enter 'Creating Order from Chaos' into cell A1. We'll define the corners of our triangle as X and Y coordinates. Type Corner, X-coordinate, and Y-coordinate into cells A3, B3 and C3 respectively. Then enter 1, 2 and 3 into cells A4, A5 and A6. Increase the width of columns B and C. Enter 0 into cells B4 and C4 to define the X and Y-coordinates of corner 1 as 0 and 0. Our triangle has sides 100 units long, so enter the following formulae to work out the coordinates of corners 2 and 3. In cell B5, enter $=B4+100 * \cos(\pi/3)$. In cell C5, enter $=C4+100 * \sin(\pi/3)$. In cell B6, enter $=B5+100 * \cos(-\pi/3)$. Finally, in cell C6, enter $=C5+100 * \sin(-\pi/3)$.

2 Next we'll define columns for our constantly changing current position. Type Current Position into cell B8, X-coordinate into cell B9 and Y-coordinate into cell C9. Enter 25 into cells B10 and C10 to represent the starting position. We'll also create a column for throwing the die, so type Die Throw into cell A8.

3 We can throw the die for the first time. Enter $=\text{INT}(\text{RAND}()*3)+1$ into A11, and you'll find that one, two or three will appear at random in that cell. Now we can generate a new position, halfway between the current position and the corner represented by the die throw. In cell B11, enter $=\text{IF}(\$A11=1,(B10+\$B\$4)/2,\text{IF}(\$A11=2,(B10+\$B\$5)/2,(B10+\$B\$6)/2))$. Into cell C11, enter $=\text{IF}(\$A11=1,(C10+\$C\$4)/2,\text{IF}(\$A11=2,(C10+\$C\$5)/2,(C10+\$C\$6)/2))$.

4 We need to do this lots of times, but we'll start with 100 to make sure everything is OK. Select A11, B11 and C11, and drag down to row 110 so all cells in the range A11 to C110 are selected. Select Fill and then Down from the Edit menu. Column A will contain the numbers 1, 2 or 3 at random and the numbers in columns B and C also appear to be random. But first impressions can be deceptive.

5 Select the cells from B10 to C110. Click the Chart Wizard icon on the toolbar at the top of the screen. In the dialog box that appears, select XY (Scatter) as the Chart Type and click Finish. Already it might be obvious that the pattern isn't random. The points tend to lie on certain lines and some areas are empty.

Plotting more points will make the pattern clearer, but first we'll format the chart so it's more suitable for displaying thousands of points. Click on the box labelled Series 1 and press the Delete key to get rid of it. Now adjust the size and shape of the chart by dragging the re-size handles until it's square and occupies the full screen. Finally, we'll make the points smaller, so right-click on one of the dark-blue diamond-shaped points and select Format Data Series from the drop-down menu. This opens the Format Data Series dialog box. In the Marker section on the right-hand side, enter 2 as the Size, which is the minimum it will allow.

If you like, you can also change the colour by selecting different values for foreground and background. Click on OK, and the chart will be drawn with the new, smaller markers.

6 Select cells A11, B11 and C11, and drag down to row 20,000 so all cells in the range A11 to C20000 are selected. From the Edit menu, select Fill and then Down. Click on the chart to select it. To modify the chart, click on the Chart Wizard icon. Click on Next in the Chart Wizard and select the Series tab. The entry next to X Values is currently $=\text{Sheet1}!\$B\$11:\$B\110 . Change the last three digits to '20000', so that it reads $=\text{Sheet1}!\$B\$11:\$B\20000 . Change the last three digits in the entry for Y Values so it also reads '20000'. Click on Finish. Amazing, isn't it?

Change the look of your chart by right-clicking on the background and choosing Format Plot Area. You can make the gridlines the same colour as the background by right-clicking on one and selecting Format Gridlines. 

